CHALMERS | CAM² REGION VÄSTRA GÖTALAND SAHLGRENSKA UNIVERSITY HOSPITAL

Investigation of the potential of additive manufacturing for hand surgery

Background

A broken wrist is a common injury after a fall. Most often these fractures heal uneventfully. However, in some patients the forearm bones, the radius and ulna, malunite. This can lead to a loss in range of motion (ROM) and pain in the wrist. In such case corrective surgery is necessary. This means, the radius and/or ulna is cut using a saw and the deformation is then corrected to an anatomical or near anatomical position and the bones are fixated using plates and screws. Following the bone cut and realignment there may be bone defects needed to be filled using bone grafts, usually taken from the pelvic bone. Currently these corrective osteotomies are planned by the surgeon using available radiographs or CT scans and the actual osteotomies are done on free hand by the surgeon using a saw. Following the osteotomy a standard metal plate is applied to fixate the bone in the desired position. This means that the precision of the cuts is rather low and the plates may not have an optimal fit on the bone, or the plates may limit the possibility to correct the bone to the extent needed. This can result in suboptimal correction of the deformity and subsequently the patient does not get the best outcome in terms of improved ROM and reduction in pain.

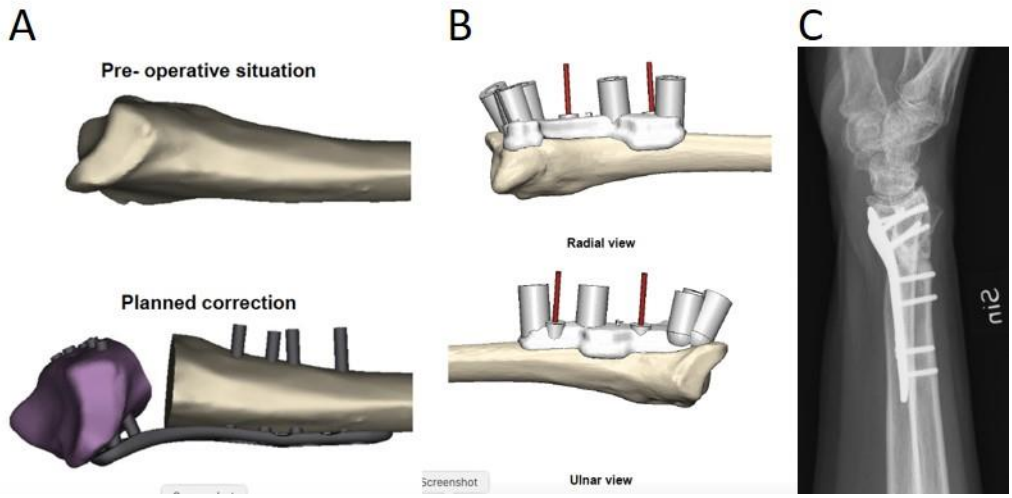

Figure 1: Patient with a defiormation in the radius bone following malunion of a fracture. A: Preoperative planning in computer. The osteotomi, where the bore should be cut to correct the deformity, is simulated. B: Based on the computer planning a guide is printed where it is marked where to cut the bone and where to place the screws in order to correct the deformity. C: Radiography showing the result. A metal plate has been applied to the fixate the osteotomy in radius.

Precise cutting of the bone and placing of the surgical plate could, however, be aided by tailor made surgical guides and plates. This is where additive manufacturing (AM) for biomedical applications offers great potential for customized solutions according to the patient's needs. Surgical guides can be developed during the planning stage and can be manufactured using polymer AM. In case of deformities that require more complicated adjustments to gain full mobility of the wrist after surgery, surgical plates can be tailored to the respective patient and produced using metal AM.

This master thesis aims to investigate and develop application strategies of AM solutions in reconstructive wrist surgery and ultimately create a common link between surgeons and AM engineers. Current practices and state of the art of wrist surgery will be explored as well as the potential AM solutions. Assessment of the entire manufacturing chain will have to be carried out, considering unique

aspects of biomedical applications such as biocompatibility and sterilization of the material. The study will be based on cases that have already been performed using either custom-made guides or custom-made plates. In these cases, a pre-operative planning has already been done and can be used for comparisons. To use existing, already operated cases, will save time but more importantly also provide a possibility for comparison with the actual outcome. Technical expertise and access to prototype prints will be provided by at Chalmers or CAM^2 network. Medical expertise and background information as well as the clinical cases will be provided by the Department of Hand Surgery at Sahlgrenska hospital.

Requirements:

We are looking for a master student with a solid background in additive manufacturing and an interest in developing biomedical applications.

Extent and time plan:

- Period (January-June 2021)
- Number of credits 30 ECTS/högskolepoäng (hp).
- The thesis is intended for one student

More information:

Contact main supervisor – Dr Fiona Schulz for more information about the project. Apply with your CV, academic transcripts and a cover letter in English. Welcome to apply!

Supervisors and examiners:

Main supervisor at Chalmers:	Dr Fiona Schulz (sfiona@chalmers.se)
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